

## Executive Summary and Key Findings

The global market for environmental technologies goods and services reached US\$ 917 billion in 2013. The United States is host to the single largest market accounting for US\$ 286.1 billion of the global market. U.S. environmental companies exported US\$ 48.4 billion worth of goods and services in 2013. The U.S. industry for environmental technologies employs approximately 2.6 million people and had revenues of US\$ 313.6 billion.<sup>i</sup>

The U.S. Environmental Export Initiative (EEI) is a sector-specific effort within NEINext, the federal government's export promotion platform, which addresses the unique role environmental export promotion plays in advancing the economic, environmental, sustainable development, and diplomatic goals of the United States.

Led by the International Trade Administration and the U.S. Environmental Protection Agency, the EEI is a government-wide initiative that leverages EPA's world-renowned regulatory and scientific expertise on solving challenging environmental problems with ITA and other U.S. Government agencies' trade policy, promotion, and finance capabilities.

The overarching goal of the EEI is to deliver, within the context of finite government resources, targeted trade promotion and policy programs that enhance the international competitiveness of the U.S. environmental technologies industry and in so doing, help mitigate global pollution problems. Specific objectives include the dissemination of U.S. technical knowledge and expertise to foreign environmental regimes; the identification and removal of trade and competitiveness barriers; and the provision of targeted industry specific export promotion services to U.S. companies.

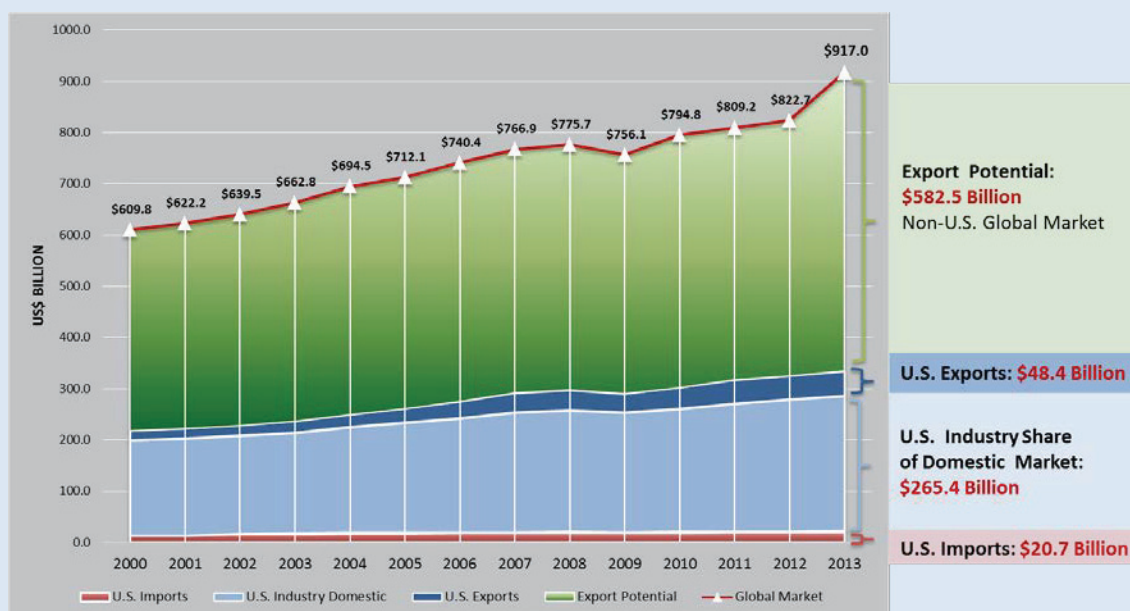
This *Top Markets Report* supports the efforts of the EEI by identifying and ranking export markets where focusing finite government resources will have the greatest impact in terms of increasing commercial opportunity for U.S. companies. This study distills market forecasts and quantitative assessments into overall market scores that identify and rank export markets relative to three critical traits: first, markets that are large and growing in absolute terms; second, those that have a defined and increasing need for imported technology and services; and, third, those where U.S. exports are lower than predicted, based on markets with similar characteristics -- this last component indicates that policy and trade barriers might exist and thus where U.S. government intervention is most helpful.

The rankings are then filtered further to adjust for mature markets that are relatively frictionless -- markets that are large and open to U.S. products and services and that boast relative ease of doing business overall<sup>ii</sup>. The final result is a list of large and growing markets where the scope of opportunity is countered by the presence of policy or other barriers; these are the markets where U.S. government policy and promotion activities have the highest potential for impact relative to the U.S. government resources available for policy and promotion activities. (see

**Figure 1: Projected Top Markets for Environmental Technologies Exports**

|    | Water             | Air                  | Waste             | Composite Environmental Technologies Score |
|----|-------------------|----------------------|-------------------|--|
| 1  | China 371.5       | China 338.7          | Pakistan 68.8     | China 773.8                                |
| 2  | India 156.6       | Mexico 172.9         | China 63.6        | India 314.1                                |
| 3  | Saudi Arabia 96.8 | Brazil 158.4         | Indonesia 47.9    | Brazil 276.5                               |
| 4  | Brazil 93.8       | Turkey 134.6         | Thailand 34.2     | Mexico 250.1                               |
| 5  | Indonesia 91.3    | India 129.8          | India 27.6        | Indonesia 215.1                            |
| 6  | Mexico 70.6       | Czech Republic 111.8 | Brazil 24.3       | Saudi Arabia 196.1                         |
| 7  | Poland 69.3       | Korea 100.4          | Vietnam 20.8      | Korea 172.6                                |
| 8  | Korea 57.6        | Saudi Arabia 82.3    | Egypt 20.4        | Turkey 171.2                               |
| 9  | Peru 57.0         | Indonesia 75.8       | Saudi Arabia 17.0 | Czech Republic 146.7                       |
| 10 | Thailand 55.0     | Poland 69.1          | Korea 14.5        | Poland 144.7                               |

**Figure 2: Global Environmental Technologies Market Overview**



Source: Environmental Business International with ITA analysis

methodology section for a detailed description of this study's methods).

The next step is a qualitative assessment of opportunities and challenges in the top 10 ranked markets. Industry and market experts collaborated on this effort to define the scope of opportunity for U.S. companies as well as to identify barriers and obstacles that should be addressed by the U.S. government. This analysis leads to the subsequent identification of programmatic and policy remedies best suited to meet both the challenges and opportunities afforded in these critical markets.

This suite of programs forms a nexus of trade promotion and policy interventions that are mutually reinforcing and affords U.S. companies an opportunity to engage in targeted policy and promotion activities.

### Understanding Global Environmental Markets

Establishing a common definition of the environmental technology industry is useful for the purposes of this report since environmental technologies can be understood as any permutation of goods and services that might fall under the category of environmentally friendly or beneficial. In practice, producers of environmental technology have a clear definition for their sector and from an industry perspective,

environmental technologies are defined as all industrial goods and services that:

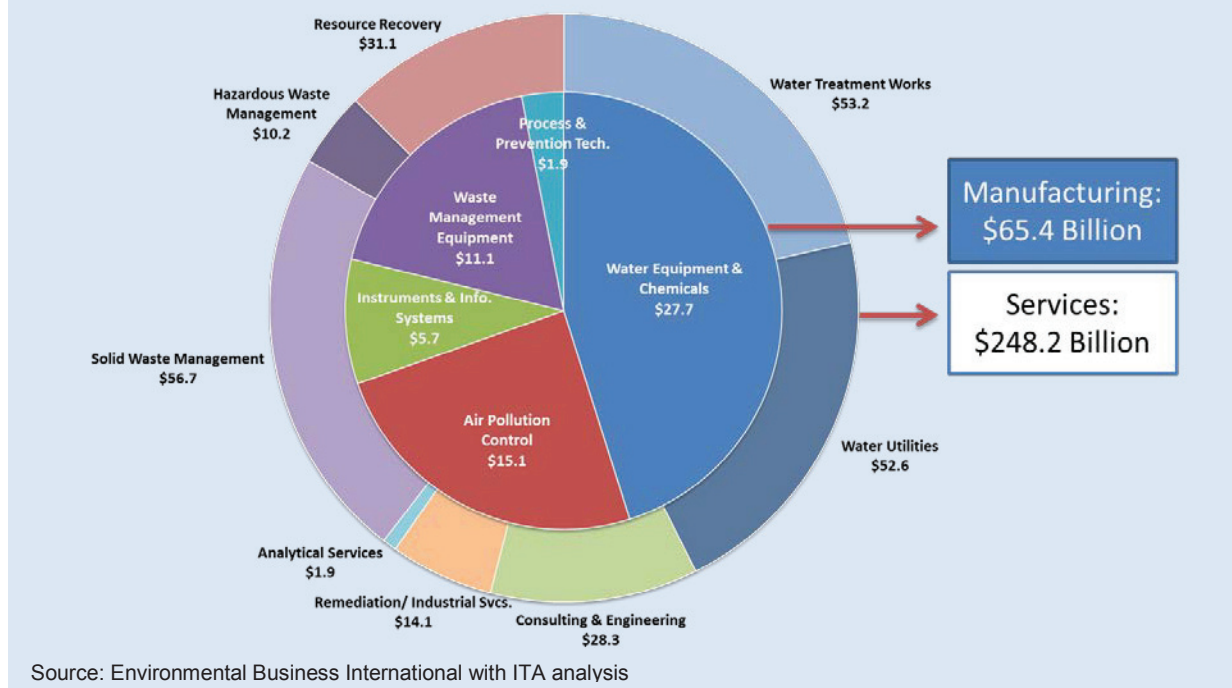
1. Foster environmental protection and physical resource efficiency in industrial settings;
2. Generate compliance with environmental regulations;
3. Prevent or mitigate pollution;
4. Manage or reduce waste streams;
5. Remediate contaminated sites;
6. Design, develop, and operate environmental infrastructure; and
7. Afford the provision and delivery of environmental resources.

Environmental technologies are generally categorized by the three environmental media they are designed to protect or provide, that is: air, water, and soil.

### Water, Wastewater, and Industrial Water

The water media category addresses the water and wastewater treatment subsector with key segments that include municipal drinking water treatment and delivery, municipal wastewater conveyance and treatment, ground and surface water remediation, industrial process water treatment, and industrial wastewater treatment. U.S. industry revenue in the water and wastewater treatment subsector in 2013 was US\$ 148.8 billion; this figure includes analytical services, wastewater treatment services, consulting

**Figure 3: U.S. Industry Revenues by Segment**



and engineering, equipment and chemicals, instruments and information systems, and utilities<sup>iii</sup>.

Municipal drinking water treatment and delivery, municipal wastewater conveyance and treatment, and ground and surface water remediation are distinct from industrial water treatment since the former deals primarily with public sector clients concerned with provision of water for human consumption and use, and the protection of water as an ecological and social resource. The public utility aspect of these markets generally translates into a low degree of market flexibility and innovation due to a relatively greater regulatory burden that is applied in order to protect human health.

Alternatively, industrial process and wastewater (sometimes called “produced water”) speak to water’s value as an economic input for any variety of industries. As an industry segment, industrial water treatment solutions are diverse and sophisticated compared to their municipal counterparts and are typically higher on the value chain overall. Generally, the cost and complexity of treatment technologies are positively related to the quality of water needed for the industrial process at hand while correspondingly the cost and complexity of treatment for industrial wastewater is positively related to the scope of

contaminant introduced during the industrial process and the regulatory burden applied to industrial effluents (i.e. water released back into public water bodies).

#### Air Pollution Control

The air media category deals with air pollution monitoring and control technologies for both stationary and mobile pollution sources. Stationary sources include emissions from thermal energy generation and those from industrial sources such as boilers, incinerators, smelters, and a variety of other emitting industries.

A substantial segment of the industry is comprised of monitoring technologies including the instrumentation and software required for public applications that monitor ambient air quality for the population at large. This segment also includes industrial and fence-line monitoring systems and software that assess specific industrial sites and applications as well as fence-line monitors for trans-boundary sources. U.S. industry revenues for air pollution control in 2013 totaled US\$ 19.3 billion including equipment, instruments, and attendance services<sup>iv</sup>.

Control technologies are determined by the scale of the emitting industry and scope of the pollutants that

are limited by the control technology. Large emitters, like concrete producers and coal-fired power plants, use systems the size of a city block that cost in the millions to produce and run. Smaller operations, such as those attached to medical incinerators, have a substantially lower footprint and cost profile. Mobile sources including marine diesel engines, non-road diesel engines, and automobile engines are a primary example of scale driven systems and unit pricing. An immediate example of the scalability of control technologies can be found in passenger vehicles which have a catalytic converter that does not exceed two feet in length and width.

#### Municipal Solid Waste, Hazardous Waste, Recycling, and Resource Recovery

The solid media category includes solid and hazardous waste management, recycling and resource recovery, and soil pollution prevention and remediation technologies. Like municipal water treatment, solid waste is subject to a high degree of regulatory burden due to the public policy considerations related to waste management. Revenues for the U.S. solid waste and recycling industry equaled US\$ 96.5 billion in 2013, driven predominantly by waste management services<sup>v</sup>.

The recycling industry is driven by demand from materials markets and its growth is positively related to the increase of price for raw materials. The hazardous waste management industry, which deals with industrial wastes that require independent treatment and storage technologies due to the potential for contamination, accounted for US\$ 18.6 billion in revenues during 2013<sup>vi</sup>.

#### Monitoring and Instrumentation

Crosscutting the three media categories is the monitoring and instrumentation subsector, which includes monitors and testing equipment for the air, water, and soil; metering technology for water treatment and conveyance; and laboratory equipment and testing services. U.S. industry revenues in 2013 for instruments and information systems totaled US\$ 6.1 billion, led by instruments for water and waste water management at US\$ 2.2 billion, followed by those for air quality US\$ 1.2 billion, and remediation at US\$ 1.0 billion.<sup>vii</sup>

#### Environmental Consulting and Engineering

Environmental consulting and engineering also spans all media categories. The industry is underpinned by practitioners who design, develop, and operate environmental infrastructure and systems.

Environmental projects can be both free-standing and part-and-parcel of larger infrastructure tenders.

An example of a free-standing environmental project includes the site assessment, design, engineering, construction, and operation of a wastewater treatment facility, whether municipal or industrial. An example of a part-and-parcel project is the site assessment, environmental impact assessment, and sustainability design components to building a new hospital.

The project definition and scope variability of this services component to the environmental sector contributes to difficulty in establishing reliable environmental industry figures. Nonetheless, Environmental Business International's (EBI) survey of the industry reports 2013 revenues of US\$ 28.3 billion in environmental, consulting and engineering.

Though interrelated in terms of their collective impact on ecology, the environmental technology media subsectors and segments generally function as independent markets driven by both regulation and demand from client industries. The implications for an environmental technology export promotion strategy are that these diverse and complex markets must be complemented by a promotion strategy appropriate to their respective market drivers.

### **Understanding Export Promotion Strategies in the Context of Global Market Drivers**

#### Rules Supersede Needs in the Global Market for Environmental Technologies

To establish an effective export promotion strategy for U.S. environmental technologies, one must dispel a common misconception of how environmental markets are established and function. Neither environmental needs, like lack of potable water, nor conservation philosophies, such as desire to steward natural resources for future generations, translate into a tangible market for environmental technologies.

Instead, environmental technologies markets develop when galvanized by the creation of an environmental protection regime. Specifically, environmental markets develop in settings where the cost of non-compliance with environmental rules exceeds that of compliance, meaning that the environmental regime must be bound by a functional system of enforcement.

**Figure 4: Challenges and Opportunities Matrix**

|            | CHALLENGES  | OPPORTUNITIES   |
|------------|---|---|
| MARKET     | <ul style="list-style-type: none"> <li>• Preferential Procurement</li> <li>• Differential Standards &amp; Regulatory Models</li> <li>• Availability of Finance</li> <li>• Government Support for Foreign Competitors</li> <li>• Low Technical Sophistication</li> </ul> | <ul style="list-style-type: none"> <li>• Unprecedented Growth</li> <li>• Regulatory &amp; Standard Development</li> <li>• Quality &amp; Sophistication of U.S. Products and Services</li> <li>• Recognition of U.S. Brand &amp; Reputation</li> </ul> |
| GOVERNMENT | <ul style="list-style-type: none"> <li>• Industry Specific Data Gaps</li> <li>• Diffuse Number of Programs</li> <li>• Diminishing Resources</li> <li>• Interagency Coordination</li> <li>• Differential Missions</li> <li>• Marketing and Communication</li> </ul>      | <ul style="list-style-type: none"> <li>• ETTAC and Private Sector Policy Development</li> <li>• Web-based &amp; New Media Tools</li> <li>• Partnerships with Key Industry Players</li> <li>• NEI Platform</li> </ul>                                  |

Source: Environmental Technologies Trade Advisory Committee (ETTAC) and ITA analysis

In the absence of enforcement, compliance failures negate the implementation and maintenance of environmental protection systems regardless of the scope of environmental challenges in market. A recent example of this is air pollution control in China. The Chinese government articulated its first air pollution control law in 1987 followed by revisions in 1995 and 2000. Despite stringent legal requirements for air pollution mitigation, the absence of an effective enforcement mechanism has led to China's pervasive and widely reported air pollution problems. Data from the U.S. Embassy in Beijing show that from April 2008 and March 2014 only 25 days qualified as "good" air quality days when measured against EPA air quality reference standards.<sup>viii</sup> The implication for export promotion is that needs-based approaches fail to accurately anticipate market opportunity.

While regulatory enforcement is typically the mode of environmental market creation, finance is the means. Environmental technology markets do not catalyze without resources to fund public environmental infrastructure projects and private environmental compliance costs. For this reason, the analysis in this study emphasizes national mechanisms to finance public environmental infrastructure in its assessment of the readiness to implement projects related to stated national environmental goals.

### **Resource Scarcity is an Emerging Driver of Environmental Technologies**

Resource scarcity and the corresponding demand for resource efficiency are evolving and important drivers of environmental technology markets. Since environmental resources, such as water, play an integral role in industrial production, their value as an input creates demand for technology that enables efficient use and reuse. An example of this relationship is the boom in investment and development of water treatment and reuse technologies for the recovery of natural gas through hydraulic fracturing. The productive value of a cubic meter of water in the hydraulic fracturing process is estimated to be about US\$ 1.54<sup>ix</sup>.

Comparatively, a cubic meter of water used in agriculture has a productive value of approximately US\$ 0.13<sup>x</sup>, which demonstrates why investments in water efficiency in natural gas extraction are seen as profit enhancing. Between 2005 and 2012, venture capital firms made an estimated \$415.1 million in investments for new treatment technologies to promote reuse of produced water and better manage the cost of process water in extractive industries.<sup>xi</sup>

Similarly, the entire recycling industry is predicated on the price of materials and the relatively lower cost of

non-virgin materials as productive inputs. As the price of virgin materials rises with energy and other associated costs and is compounded by overall scarcity, the demand for recycled materials will continue to grow along with the technologies required to produce them.

Similarly, capital efficiency and industrial hygiene demands can introduce the need for environmental technologies. A poignant example is the need for mercury removal technologies in gas combustion power plants since even low levels of mercury present in the natural gas fuel stream can destroy heat exchangers and other essential energy production equipment.

Demand for resource efficiency-driven environmental technologies is expected to increase as resource scarcity is compounded by demographic, social, and ecological trends including climate change, population growth, urbanization, and per capita income growth and attendant consumption pattern changes.

### **Export Promotion in Environmental Technologies**

The United States hosts a comparatively advanced and sophisticated environmental technologies industry. The U.S. brand itself is highly valued globally, and U.S. environmental products are generally recognized for their excellence in innovation, engineering, and durability. This reputation stems from the maturity and independence of the regulatory regime through the United States Environmental Protection Agency (EPA).

EPA's application of scientific rigor and its separation from industry interests in its rule making process has lent it a global reputation as the gold standard in environmental protection policy making. Thus the industry that EPA helped promulgate receives similar respect for the efficacy of its systems. Global buyers also recognize the U.S. brand for the services associated with U.S. environmental technologies, which emphasize long-term business and engineering relationships over short-term sales opportunities. Despite the recognized excellence of the U.S. industry, companies face a variety of challenges in the international market:

#### Business Time Horizons

The time horizon for fostering a business relationship that leads to the sale of an environmental system typically takes one to five years. For international markets, this translates into a substantial corporate

investment in time and resources to develop a business partnership.

#### Preferential Procurement Practices and Cost/ Quality Trade-offs

The sophistication of U.S. products coupled with the cost of production in the United States has a corresponding effect on price. The high price differential for U.S. technologies and systems can negate competitiveness in low-income markets. U.S. products may also be foregone in the short-term for lower-cost and less durable alternatives despite the long-term operational cost competitiveness of U.S. products. Similarly, preferential procurement practices that favor domestic competitors or competitors from aid-donor countries can create an overall environment of unfair competition for U.S. companies.

#### Tariffs

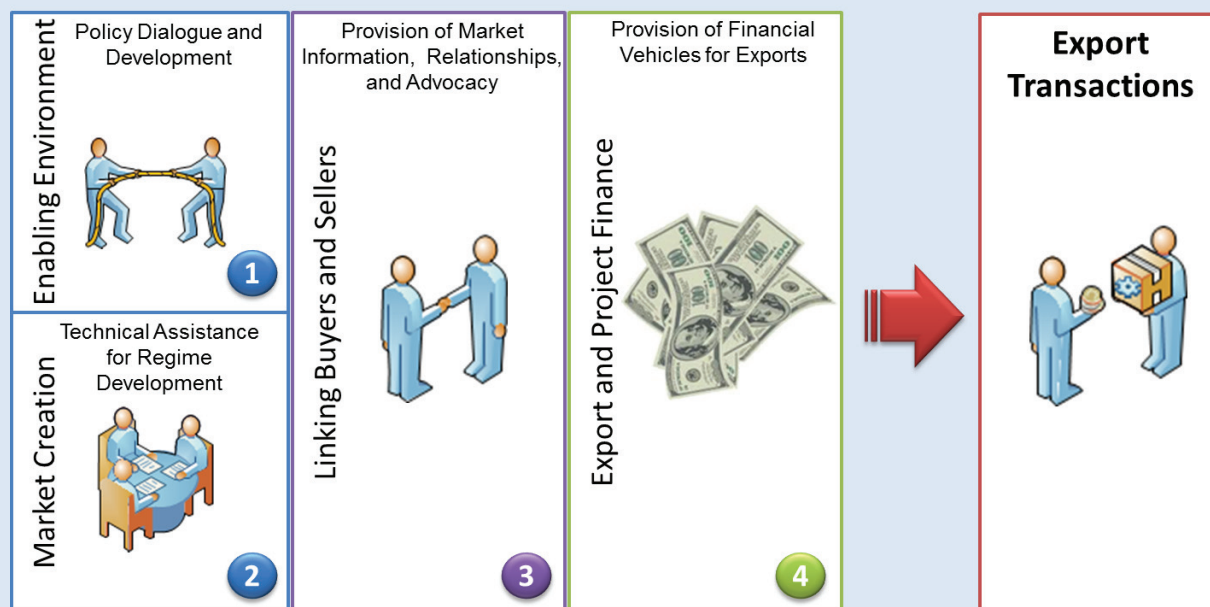
Tariffs remain a substantial and limiting barrier to trade in environmental technologies. The United States Trade Representative (USTR)<sup>xii</sup> reports tariff peaks in environmental technologies among World Trade Organization (WTO) members of 20 percent for air pollution control, waste management and recycling, and monitoring and instrumentation products. Tariffs for water and wastewater products are as high as 21 percent. In many markets, high tariffs compound the price differential for U.S. environmental technologies, making U.S. products prohibitively expensive in many markets or eroding profitability of U.S. goods in export markets.

#### Standards, Regulation, and Certification

Beyond tariffs, substantial and often insurmountable barriers exist for U.S. companies with respect to different standards regimes, lack of regulatory compatibility, and failure to provide mutual recognition of product and professional certifications.

The United States drives innovation in part through its approach to standards, which emphasizes performance-based measures of conformity where practicable and predicates standards and testing protocols on the principles of science, risk assessment, and cost-benefit analysis. This creates conflict in foreign markets that emphasize design-based standards models and utilize the precautionary principle in developing standards and regulation, an approach which eliminates the practicability of performance-based design, stymies innovation, and narrows the field of applicable technologies to those developed within the destination market. It also

**Figure 5: Environmental Technologies Export Promotion Process**



Source: ITA/Office of Energy and Environmental Industries

imposes onerous additional fees for testing and conformity assessment to similarly performing technologies and equally rigorous professional certifications.

#### Data Gaps and Asymmetrical Market Information

Weak trade and market data has plagued the environmental technologies industry for some time. Neither the Harmonized Tariff System (HTS) nor the North American Industrial Classification System (NAICS) accurately addresses the breadth of technologies and services within the industry, and therefore assessing market size and opportunity is a persistent problem. (See methodology section for how these gaps are addressed in this study).

The U.S. market is large and, until recently, substantial enough to support the business aspirations of many U.S. environmental technology providers. However, saturation in the U.S. market coupled with explosive growth in emerging markets makes international growth inextricably linked with companies' growth. Small- and medium-sized enterprises need to identify markets where their technologies are in demand and develop the business relationships that will lead to future sales. The lack of market data makes it difficult to determine where opportunities are the greatest and

makes it difficult for individual companies to discern where their specific products are in demand.

#### U.S. Government Resources and Coordination

U.S. Government agencies face a variety of challenges in promoting environmental exports. These challenges include a lack of the time and resources to effectively conduct interagency coordination; different missions which may subordinate export promotion as a priority; diminishing staff and budget resources for program implementation; and limited mechanisms to transmit market information to industry and individual companies.

#### **The Role for U.S. Government**

Given environmental technologies' market drivers and challenges both the industry and the U.S. Government experience, successful export promotion in this sector has four critical components:

1. Policy dialogue and development;
2. Technical assistance for regulatory development and environmental management;
3. Direct promotion and advocacy; and,

4. Financial vehicles for project development and export finance.

#### Policy Dialogue and Development

The objectives of policy dialogue and development are two-fold: 1) Identify and eliminate existing trade barriers; and 2) Prevent new barriers from forming in order to generate an enabling environment for environmental technologies exports. This is achieved through bilateral, regional, and multilateral fora. Current efforts include elimination of tariffs for environmental goods through plurilateral negotiations to achieve an Environmental Goods Agreement in the World Trade Organization.

Important regional discussions and negotiations include the Transatlantic Trade and Investment Partnership with the European Union and the Trans-Pacific Partnership and Asia Pacific Economic Cooperation discussions in Asia, while key bilateral fora include the U.S. – China Joint Commission on Commerce and Trade Environment Working Group and the U.S. – Brazil Commercial Dialogue.

#### Technical Assistance for Regulatory Development and Environmental Management

The regulatory nature of the industry means that the U.S. Government can be particularly effective in facilitating the creation and expansion of environmental export markets by providing technical assistance that creates opportunities to encourage the development of compatible regulatory approaches and an attendant compatible industrial environment. Technical assistance increases understanding of the efficacy of U.S.-style approaches, particularly the emphasis on solutions underpinned by science. Technical assistance can also yield favorable market results when it facilitates the creation of mechanisms for enforcement as well as knowledge and expertise for the maintenance and management of environmental systems.

The interagency engages in “soft” technical assistance by providing publicly available resources such as the U.S. Environmental Solutions Toolkit (URL), which is an online searchable database that marries EPA scientific and regulatory expertise with a catalogue of technology providers for specific environmental issues. There are also a variety of ‘hard’ technical assistance programs including the series of Memoranda of Understanding that EPA develops with partner

governments to provide technical know-how to foreign regulators.

Since failures of environmental systems can harm human health, the risk associated with implementing new technologies is high and can prevent the introduction of new technologies altogether. Similarly, a lack of technological know-how is a formidable barrier to the development and implementation of environmental systems. The U.S. Trade and Development Agency works to address both of these challenges by funding demonstration projects in select emerging markets and educating foreign officials and buyers through reverse trade missions (RTMs).

#### Direct Promotion and Policy Advocacy

Direct promotion and policy advocacy facilitates company and industry export sales by identifying and advocating for the removal of acute trade barriers and by delineating market opportunities and facilitating subsequent business relationships. ITA, along with other U.S. Government agencies, provides businesses with market information, trade counseling, and opportunities to develop international business relationships.

#### Provision of Financial Vehicles for Project Development and Export Finance

Finance is a limiting factor to environmental technologies exports, from both the project development and export finance perspective. The Overseas Private Investment Corporation helps fill the gap in project development finance by funding and facilitating the development of foreign infrastructure projects. Direct export finance is provided to U.S. companies through the Export-Import Bank of the United States which provides a suite of export finance and insurance products to facilitate export transactions.

#### **Top Markets in Context**

The subsequent chapters of this report provide a market and policy overview of the top nine global markets where U.S. trade policy and promotion interventions can yield the best results for the U.S. environmental industry. The country analysis is supplemented with an overview of existing U.S. Government programs that support policy and promotion in these markets.

### **Country Case Studies**

The following pages include country case studies that summarize export opportunities in selected markets. The overviews outline ITA's analysis of the U.S. export potential in each market. The markets represent a range of countries to illustrate a variety of opportunities in the global market place.

Interagency activities listed are intended to provide an overview of targeted programs for these markets. Some activities, which are not mentioned, are effective in all markets. Webinars, market assessment reports, the International Buyers Program, and other trade events reach a wide cross-section of exporters and provide important information to U.S. companies about opportunities overseas and should continue as such.

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# China

China is the largest and fastest growing emerging market for environmental technologies. The overall environmental technologies market in China (including goods and services) is valued at \$27.35 Billion (2012).<sup>1</sup> China ranks 1<sup>st</sup> overall on the 2015 Top Markets Study (TMS) with a Composite Environmental Technologies Score of 773.8. China ranks 1<sup>st</sup> for both air pollution control and water markets with a score of 338.7 and 371.5 respectively. China ranks 2<sup>nd</sup> for waste and recycling with a score of 63.6 (see appendix A for global rankings).

|              |   |                       |   |
|--------------|---|-----------------------|---|
| Overall Rank | 1 | Air Pollution Control | 1 |
| Water        | 1 | Waste & Recycling     | 2 |

The scope, size, and expected growth of China's market for environmental technologies is unmatched but market barriers, particularly those related to protection of intellectual property, continue to make China a challenging market in which to operate.

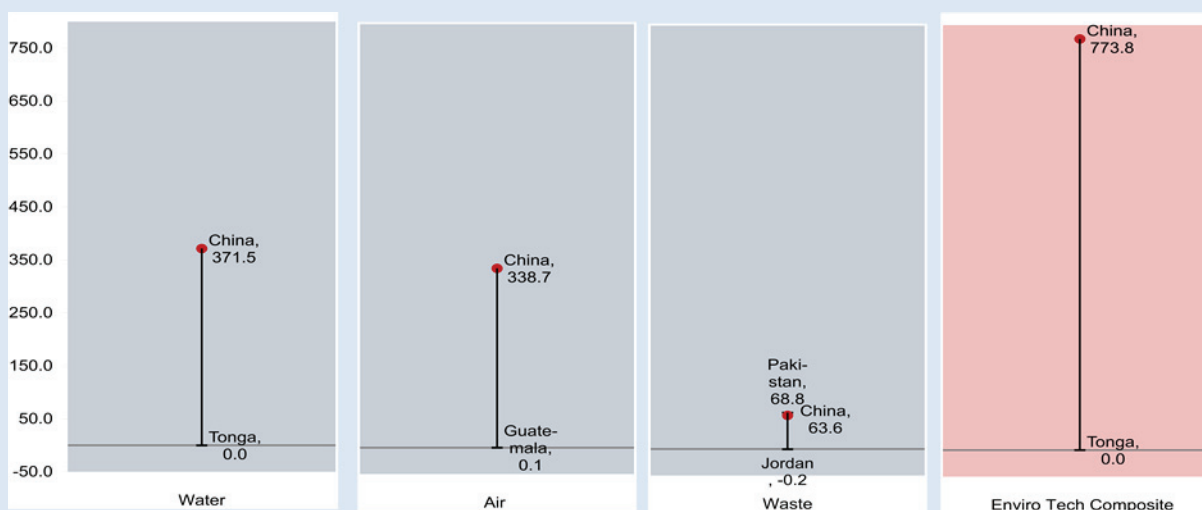
## STATE OF THE ENVIRONMENTAL REGIME

China's environmental regime has improved in recent years with the development of a national legal framework that supports the mitigation of pollution across all three environmental media. However, enforcement remains weak in many areas, since it is delegated to municipal and regional governments whose focus rests almost entirely on economic development. Recently, China has fundamentally restructured its approach to environmental regulatory enforcement with the introduction of the amended

Environmental Protection Law (EPL) on January 1, 2015 which could yield greater adherence to environmental rules if incentives and penalties therein are greater than the cost of non-compliance.

The Environmental Business Journal-OECD Environmental Stringency Survey, which ranks environmental regimes on a scale from 1 – 7 (with 1 being lax and 7 being among the most stringent in the world), substantiates the business perception of improved environmental rules in China. China scored a 3.6 in 2012, a 1.8 point improvement on its 2005 score of just 1.8. Similarly, China scored a 4.11 on the World Economic Forum's 2011 Index for Regulatory Stringency (on a similar scale to EBJ-OECD) while China's score in the same survey for enforcement was just above the median at 3.82.

**Figure 1: China Top Markets Scores**



Although assumptions about the effectiveness of the EPL once implemented are premature, the legal text highlights improved efforts at monitoring, a path towards legal recourse to address public harm imposed by polluters, authority to halt projects that exceed pollution limits, and daily fines towards polluters that exceed the cost of compliance.

## MARKET BARRIERS

Market barriers in China are persistent and prohibitive in many cases. In its most recent charter, Secretary Pritzker's Environmental Technologies Trade Advisory Committee (ETTAC), along with industry experts in the Office of Energy and Environmental Industries (OEI), identified the following barriers as most problematic for environmental technologies companies attempting to export to, or work in, China:

**1. Insufficient enforcement of intellectual property protection laws.**

Significant and widespread intellectual property theft continues to plague U.S. businesses working in China and provides a disincentive to operate in the country.

**2. Anticipate additional costs to utilization of advanced environmental technologies.**

The introduction of new or novel technologies and processes often requires the development of a demonstration project to prove the efficacy of the technology, which may come at the expense of the company. Since environmental rules are enforced on the municipal and provincial level, it could be necessary to repeat this process in several provinces.

**3. Local certifications and safety approvals fail to recognize equivalents from exporting market.**

The ETTAC reports that many certifications, such as the CMC certificate, are available only for locally produced products. Furthermore, government tenders sometimes demand special certifications which are only granted to local products.

## MARKET OPPORTUNITIES

### AIR POLLUTION CONTROL

#### Ambient Air Monitoring

In late 2013 the State Council issued the Airborne Pollution Prevention and Control Action Plan. The state air plan stipulates a 25 percent reduction in particulate matter for the Beijing-Tianjin-Hebei region, a 20 percent reduction for Shanxi and Shandong, and a 10 percent reduction for Inner Mongolia. With the exception of Beijing, no other cities included in the plan have sufficient monitoring networks to establish the baseline for reductions or to monitor progress.<sup>xiii</sup> Implementation of the state plan will thus require development of a series of ambient air monitoring networks across the five regions identified in the plan and should yield opportunities for U.S. air pollution monitoring and instrumentation companies.

#### Technologies and Services in Demand:

- Continuous emissions monitoring systems
- Ambient air quality monitoring equipment
- Source emissions measurement technologies
- Analytical and laboratory testing goods and services
- Air pollution control equipment
- Fuel vapor control systems

#### Industrial Air Pollution Reduction

The Beijing Air Pollution Control Action Plan includes a budget of US\$ 163 billion of measures to reduce airborne pollutants by 2017. Among the stated goals for industry is a 30 percent reduction in criteria pollutants and a 50 percent reduction of Volatile Organic Compounds (VOCs) from the iron, steel, cement, chemical, and petrochemical industries. If enforced, this ambitious emissions reduction effort will require the immediate implementation of control technologies at industrial sites. Industries that will be of the highest interest for the application of control technologies include iron and steel plants, oil refineries, non-ferrous metallurgical plants, coal boilers, and petrochemical plants.

#### Key Technologies in Demand:

- Wet/dry scrubbers (particularly systems that remove multiple pollutants)
- Carbon injection systems (for reduction in mercury and organics)
- Particulate matter control systems (particularly new bagging systems)

- NOx, mercury, CO2, and particulate matter monitoring and continuous monitoring systems
- Selective catalytic and non-catalytic reduction controls
- Oxygen enrichment, fuel injection, and other efficient combustion technologies
- Innovative specialty cements
- Mixing technologies
- Pumping and fluid handling equipment
- Engineering and plant design
- Leak detection equipment
- Alternative fuel technologies used to fire cement kilns

#### Power Plant Emissions Reduction

The Chinese power generation sector is heavily reliant on coal and in the past has applied few if any central measures to reduce particulates and other criteria pollutants such as Sulfur oxides (SOx), nitrogen oxides (NOx), and mercury. Coal-fired power plants generated 67.5 percent of China's energy in 2013,<sup>xiv</sup> significantly contributing to air quality issues in the region. Thus reducing coal-fired based emissions is a key pillar in the 2013 State Council plan for air pollution control.

The Hebei region relies heavily on coal-fired power to fuel the nation's steel industry, but has committed nonetheless to a reduction in coal consumption of 40 million tons. Maintaining production while reducing coal consumption will require switching to cleaner burning fuels and administering control technologies. Similarly, the Beijing Air Pollution Control Action Plan stipulates an approach to power generation that includes fuel switching to natural gas.

The Chinese Government has also ratified the Minamata Convention on Mercury. The convention is an international and legally binding instrument to reduce mercury use and emissions. The text of the Minamata Convention was adopted by over 150 countries, including China, in January 2013. Given that coal-fired power plants represent a major source of airborne mercury (and other toxins); the implementation of this instrument will further foster Chinese interest in air pollution control emission control technologies. Furthermore enforcement of the new reduction targets is expected to increase. The Ministry of Environmental Protection dedicated a team in November 2013 to investigate and audit coal-burning heat plants exclusively.

#### Key Technologies in Demand:

- Continuous emissions monitoring systems

- Dry sorbent injection technologies
- Flue gas desulfurization equipment
- Activated carbon injection technologies
- Inspection, adjustment, maintenance, repair services
- Selective catalytic reduction technologies

## **WASTE MANAGEMENT AND RECYCLING**

#### Solid Waste and Recycling

Outlined in China's Five Year Plan (2011 – 2015), goals for recycling and solid waste include comprehensive resource recovery from bulk solid waste such as public associated mineral resources, coal powder, coal gangue, industrial by-product gypsum, refining and chemical waste, tailings, construction waste, as well as straw, livestock wastes, and waste wood. The government of China would like to achieve a comprehensive utilization rate of 72 percent by the end of the Five-Year Plan period.

#### Key Technologies in Demand:

- Waste piles
- Composting equipment
- Sorting machines
- Crushing and grinding machines
- Materials handling equipment
- Collection services, containers, and vehicles
- Recycling process expertise

#### Recycling of Discarded Electronics

In 2011, the Chinese government implemented a series of regulations to guide the domestic processing of discarded electronics and electrical appliances called the *Rules on the Administration of the Recovery and Disposal of Discarded Electronic and Electrical Products (or China WEEE)*. The Ministry of Environmental Protection estimates that 1.7 million tons of electronic scrap was generated domestically in China in 2006, which would increase to 5.4 million tons by 2015.<sup>xv</sup> China's current electronic scrap recycling infrastructure is dominated by small-scale collection operations, informal recycling facilities, and outdoor recycling markets.

Guided by the Ministry of Environmental Protection and funded by a levy on electronics sold throughout the country, the current recycling infrastructure will be replaced by a large network of sophisticated electronics recycling facilities. In 2011 the Institute for Scrap Recycling Industries (ISRI) estimated that 6 percent of U.S. export sales of scrap equipment were destined for China.

The relatively sudden explosion in Chinese demand for equipment and recycling services present opportunities to U.S. companies with experience in providing equipment or services used in the safe and efficient recovery of valuable materials from discarded electronics.

#### Key Technologies in Demand:

- Sorting machines
- Crushing and grinding machines
- Materials handling equipment
- Collection services, containers, and vehicles
- Recycling process expertise

#### Hazardous Waste Management

In November 2012, the Chinese government adopted an action plan to address mounting environmental and health issues related to improperly managed hazardous waste (medical, chemical, and heavy metal). The Chinese Ministry of Environmental Protection estimates 60 million tons of hazardous waste will be produced annually by 2015.

With current disposal capacity at approximately one third of that amount, there is an urgent need to develop disposal capacity commensurate to the scope and size of waste production. Four billion dollars have been set aside to construct 300 hazardous waste disposal facilities and initiate brown field remediation projects throughout China.

#### Key Technologies in Demand:

- Waste handling equipment
- Waste treatment technologies
- Brownfield site remediation design and equipment
- Soil contamination testing and monitoring equipment

### **WATER AND WASTEWATER TREATMENT**

The Ministry of Environmental Protection is currently drafting a Clean Water Action Plan in the same vein as the State Council's Clean Air Plan. The plan will seek to address pervasive and persistent pollution problems with both ground and surface waters. Key themes under consideration are improved industrial effluent management, municipal wastewater treatment, and treatment approaches for rural areas.

#### Municipal Water and Wastewater Treatment and Plant Development

Aggressive construction of water treatment plants continues as China works to improve water quality and enhance access to drinking water and sanitation services. The Ministry of Environmental Protection (MEP) announced in 2014 it would invest US\$ 329 billion in addressing water pollution which will include treating municipal and industrial wastewater.<sup>xvi</sup> In the coming years, China hopes to protect the drinking water sources and improve the water quality in centralized drinking sources. The government hopes to expand and promote the protection and management of important water resources.

The China Greentech Initiative (CGTI) reports that 40 billion cubic meters of urban water supply capability will be added by 2015. Furthermore, the South-to-North Water Diversion Project mandates the construction of 426 wastewater treatment plants along the eastern route to treat heavily polluted surface waters.<sup>xvii</sup> Tightening of national regulations will provide retrofit opportunities for existing plants to move beyond mechanical treatment alone and introduce improved chemical and biological methods. In the 2015 – 2016 tender period the total value of wastewater and desalination projects expected to be tendered is US\$528 million across 13 projects.<sup>xviii</sup>

#### Key Technologies in Demand:

- Waste handling equipment
- Engineering, procurement, and construction services
- Advanced filtration
- Membrane filtration
- Waste to energy technology
- Anaerobic digestion
- Nitrification
- Biological denitrification
- Monitoring equipment
- Testing equipment

#### Sludge Treatment

China discharges approximately 22-30 million tons of untreated sludge annually,<sup>xix</sup> a growing and persistent environmental challenge. Recent government action has led to the development of technology standards for sludge treatment, a requirement that municipalities install sludge treatment systems, and a central government capital development investment of RMB 60 billion (US\$ 9.6 billion) for sludge treatment

facilities. Nonetheless, lack of domestic operational expertise and technology for sludge treatment remains a challenge for China that could provide sludge treatment opportunities for U.S. firms.

In February 2011, the National Development and Reform Commission (NDRC) and Ministry of Housing and Urban-Rural Development (MOHURD) issued plans for developing sludge treatment demonstration projects using advanced technologies. U.S. involvement in those demonstrations could enhance down-stream export opportunities. The municipalities of Beijing, Guangdong, Hebei, and Hubei are top prospects, having set 100 percent treatment targets by 2015.<sup>xx</sup>

Key Technologies in Demand:

- Engineering and design
- Anaerobic digestion
- Bio-gas/natural gas recovery

#### Groundwater Monitoring, Pollution Prevention, and Remediation

Much of China's groundwater resources have been degraded by pollution, limiting their use as a reliable source for drinking water. The Ministry of Land Resources reports that 57 percent of ground water ranks 'bad' or 'very bad' in quality estimates.<sup>xxi</sup> The *National Groundwater Contamination Prevention and Remediation Plan* calls for an RMB 34.7 billion (US\$ 6.2 billion) investment through 2020. Groundwater protection efforts are focused on monitoring, source control, and remediation.

The 12<sup>th</sup> Five-Year Plan delineates the study of pollution assessment, monitoring, and simulation in order to establish a national monitoring system and quality standards. Source control research focuses on hazardous waste storage, landfill contamination, oil and gas extraction, mining, agriculture, and underground piping and disposal systems to establish control techniques and rules. China seeks to address contaminated groundwater by conducting a groundwater pollution remediation pilot study that will inform national approaches to groundwater remediation and lead to subsequent large-scale remediation projects. U.S. Superfund experience in environmental remediation creates a competitive advantage for U.S. companies.

Key Technologies in Demand:

- Monitoring equipment
- Source pollution control technologies
- Sparging

- Bioremediation
- Chemical treatment
- Flushing
- In-situ air stripping
- Multiphase extraction
- Permeable reactive barrier
- Phytoremediation
- Pump and treat

#### Water efficiency and reuse

China's scarce fresh water resources have made water efficiency and reuse a national priority designed to limit further economic disruptions due to water shortages. These priorities will be a boon to membrane, non-revenue water management, and industrial water efficiency technologies. It is estimated that water reuse will lead to 30 percent annual growth over the next five years in the membrane technology market.<sup>xxii</sup>

Key Technologies in Demand:

- Engineering and design
- Monitoring equipment
- Non-revenue water control software
- Membranes
- Advanced filtration
- Low-loss distribution equipment
- Storage equipment

#### Process and Produced Water

New effluent regulatory requirements and better enforcement thereof are driving growth in produced water treatment, while continued industrial expansion and water reuse targets promote the process water market. China anticipates strengthening pollution control in many of its water-intensive industries, particularly in pulp and paper, printing and dyeing, chemicals, leather and large-scale livestock and poultry. Investments in improved effluent management are expected to reach RMB 125 billion (US\$ 20.1 billion) by 2015.<sup>xxiii</sup>

The State 12<sup>th</sup> Five-Year Plan targets nine sectors for improved produced water treatment: paper and pulp, raw chemicals, petroleum refining, textiles, dyeing, pharmaceuticals, ferrous metals processing, food processing, and power generation. The China Greentech Initiative has developed a list of top tier client industries using government prioritization, pollution reduction targets, discharge volumes, and treatment profitability measures. They include pharmaceuticals, beverages, paper and pulp, raw chemicals, textiles, agricultural food processing, and

coal mining and washing. Second tier industries include ferrous metal processing, petroleum refining, tobacco, food manufacturing, and chemical fibers.<sup>xxiv</sup>

Key Technologies in Demand:

- Engineering and design
- Monitoring equipment
- Membranes
- Advanced filtration

Soil remediation

A result of weak or non-existent waste management strategies including the failure to develop sanitary landfills has led to prevalent soil pollution. The Ministry of Environmental Protection and the Ministry of Land Resources report that 16.1 percent of China's soil is polluted<sup>xxv</sup> and of this total, 19.4 percent of arable land is polluted. Much of this contamination is non-organic with the most prevalent pollutants being cadmium, nickel, and arsenic. Soil pollution threatens the safety of agricultural products and contributes to groundwater pollution through leaching.

The government is in its early stages of planning a national effort to address soil pollution but in the coming years a substantial remediation effort should yield opportunities for U.S. providers of remediation technology and services.

Key Technologies in Demand:

- Engineering and design
- Monitoring equipment

Environmental Engineering and Consulting

The new Environmental Protection Law stipulates that all new construction projects must undergo an Environmental Impact Assessment (EIA) before construction permits can be issued.<sup>xxvi</sup> Similar to the U.S. National Environmental Policy Act (NEPA) if fully implemented EPL will develop a massive industry for EIAs, and area where U.S. environmental engineering and consulting firms have substantial expertise.

Key Technologies in Demand:

- Environmental Impact Assessment

**ETWG AGENCY ACTIVITIES**

U.S. – China Environmental Industries Forum (EIF)

In 2015 EIF will engage U.S. and Chinese officials and businesses in a series of technical and policy-oriented discussions designed to enhance the U.S.-China commercial and environmental partnership. The goal

of the EIF is to facilitate the development of a robust environmental protection regime and corresponding environmental technology markets. The 2015 EIF will include separate technical and policy tracks. The technical track will focus on air pollution monitoring and control methods. The policy track will focus on engagement on environmental issues overall and helped delineate areas of future/continued engagement.

U.S. Environmental Solutions Toolkit

The toolkit compiles EPA's environmental regulations, related underlying research, and a directory of U.S. companies that provide technologies necessary to implement similar environmental regulatory actions abroad. A Mandarin language version of the Toolkit was recently introduced.

The toolkit is used by EPA officials and environmental consultants as a reference tool within bilateral activities that focus on addressing environmental concerns and in fostering U.S.-Chinese partnerships. This includes the U.S.-China Joint Commission on Commerce and Trade; the Air Action Plan of the U.S.-China Strategic and Economic Dialogue's Ten-Year Framework on Energy and Environment; the U.S.-China Joint Committee on Environmental Cooperation, and others.

Power-Gen International Buyers Program

Power-Gen, one of the leading U.S. power generation equipment and services trade shows, has partnered with the Department of Commerce's International Buyer Program to encourage foreign participation in the show. This platform is leveraged to discuss policies and exchange technical information regarding power plant emissions control with Chinese participants and to foster business relationships between Chinese end-users and U.S. emissions control providers.

WasteExpo International Buyers Program

WasteExpo, one of the leading U.S. waste management trade shows, has partnered with the Department of Commerce's International Buyers Program to encourage foreign participation in the show. This platform was leveraged to exchange relevant technical information with Chinese participants and to introduce Chinese buyers to U.S. waste management technology providers.

Water Environment Federation Technical Exhibition and Conference (WEFTEC) International Buyers Program

The Department of Commerce, through its International Buyers Program, leads a delegation of Chinese officials and business representatives to WEFTEC to explore relevant U.S. technologies and work with U.S. exporters on approaches to water resource management.

promote the use of U.S. technologies in China's rapidly growing water treatment sector.

#### Green Cement Best Practices Guide

The stated goal of the Chinese Ministry of Environmental Protection's is to create a *Green Cement Best Practices Guide*. For years, the U.S. government has worked to support green cement efforts in China, including funding the development of the "BEST" tool (Benchmarking Energy Efficiency Standards Tool) which recommends best practices to improve cement kiln combustion efficiency and limit air pollutants. These activities are being leveraged to support the completion of a Chinese Best Practices Guide and are utilized in various bilateral forums to introduce Chinese end users to relevant environmental solutions providers.

#### Mercury Reduction Engagement

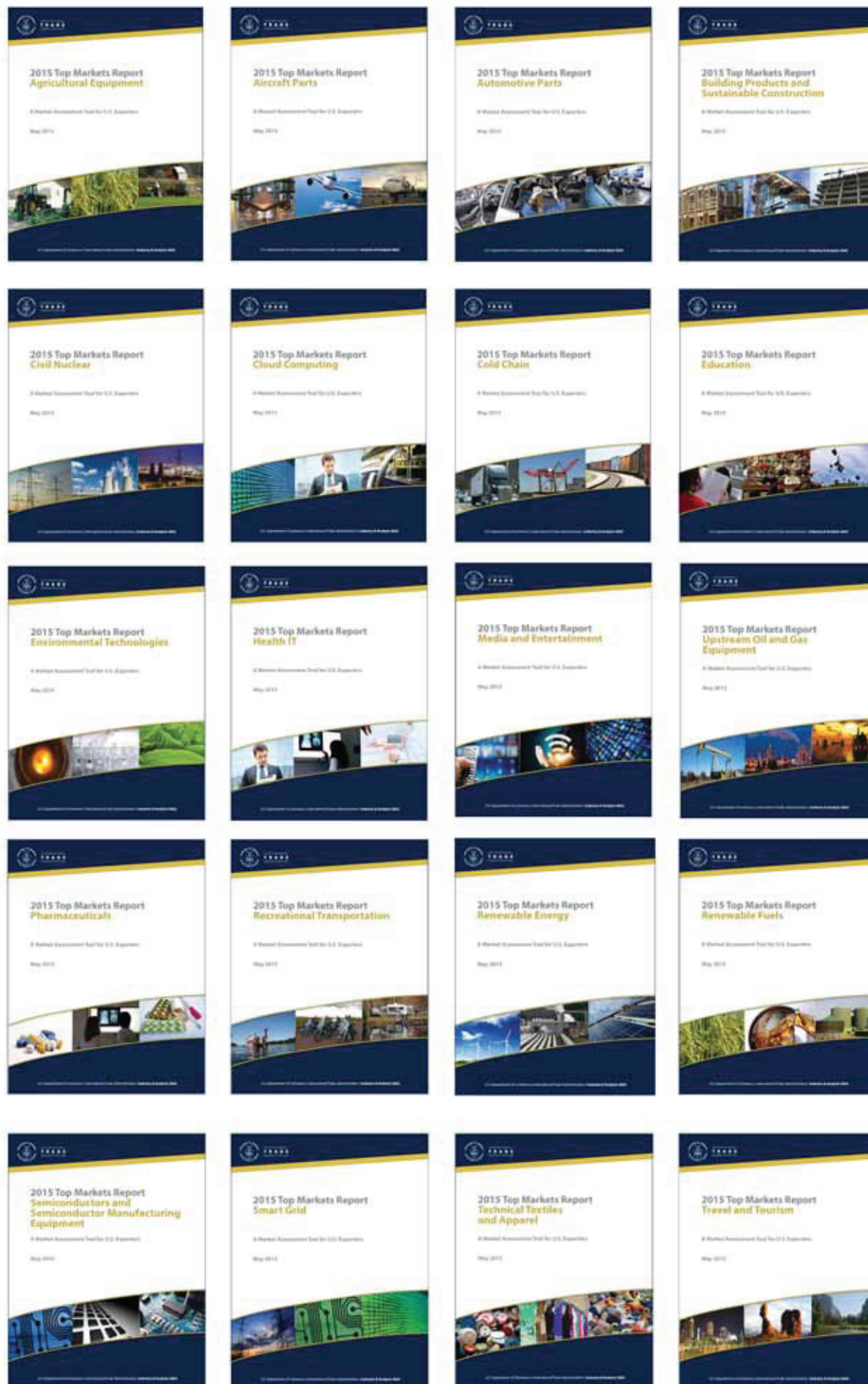
The United States and China are exchanging experiences in tackling various environmental concerns caused by mercury, highlighting existing approaches and required technologies. Improperly handled solid state mercury can contaminate the environment, as can airborne mercury falling back to earth. This engagement is advancing goals related to commitments made during recent international mercury reduction negotiations and supports the Chinese efforts to improve hazardous waste management and remediation practices.

#### CIEPEC U.S. Pavilion

The China International Environmental Protection Exhibition and Conference (CIEPEC) is the Ministry of Environmental Protection's biennial sponsored trade show and conference. CIEPEC draws officials from all regional Environmental Protection Bureaus (EPBs) and municipalities, providing access to the tendering organizations that are developing water and wastewater treatment plant projects. A U.S. pavilion during CIEPEC provided U.S. companies with an opportunity to promote their participation in specific projects.

#### Clean Water Trade Mission

The Market Development Cooperator Program (MDCP) recipient U.S.-China Cleantech Center will lead a clean water trade mission to China in June of 2015 to



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